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Lives Lost, Lives Saved: A Comparative Analysis of Avoidable Deaths at Hospitals Graded by The Leapfrog Group

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by

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About the Armstrong Institute

Established in 2011, the Armstrong Institute partners with patients, their loved ones and all interested parties to end preventable harm, to continuously improve patient outcomes and experience, and to eliminate waste in health care delivery, both at Johns Hopkins and around the world. Led by Peter Pronovost, the institute develops and tests solutions in safety and quality improvement that can then be shared at the regional, national and global levels. Using a scientific approach to improvement, the organization employs robust measures that can be broadly disseminated and sustained. More information about the Armstrong Institute is available at hopkinsmedicine.org/armstrong_institute/.

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Introduction

In 2012, in an effort to provide patients and health care consumers with information on the safety of their local hospitals, The Leapfrog Group introduced the Hospital Safety Score, a letter grade rating for hospitals on how safe they are for patients. The Hospital Safety Score is a composite score of 30 measures of patient safety that are all currently used in national measurement and reporting programs. The Hospital Safety Score uses performance measures from the Leapfrog Hospital Survey, the Agency for Healthcare Research and Quality (AHRQ), the Centers for Disease Control and Prevention (CDC), the Centers for Medicare and Medicaid Services (CMS), and the American Hospital Association's Annual Survey and Health Information Technology Supplement. Hospital Safety Scores are assigned twice a year to more than 2,500 hospitals across the nation. From the calculated scores, hospitals are assigned a letter grade ranging from A to F, with "A" hospitals having the highest scores and "F" hospitals having the lowest scores.

Leapfrog's membership of employers and other purchasers of health care have been interested in helping consumers understand the relative risk of using an "A" hospital versus hospitals that receive lower grades. Leapfrog asked the Armstrong Institute to conduct an analysis of the estimated number of avoidable deaths in hospitals with each letter grade ("A" vs. "B" vs "C" vs "D, F") and how many lives could be saved if all hospitals in the U.S. that receive a Hospital Safety Score had a safety record of "A" hospitals.

Methods

Measures Used

Fifteen outcome measures and one structural measure from the Spring 2016 Hospital Safety Score were used in the analysis. The measures included in the analysis were those for which the literature has clearly identified an attributable mortality to the patient safety event or a closely-related prevention process. Table A (Appendix) reflects the list of measures used in the analysis, the data source for each measure, and the reporting period covered by the measure.

Estimating Incidence of Errors

Using data from those hospitals that received a Spring 2016 Leapfrog Hospital Safety Score, the mean incidence rate of each patient safety outcome was calculated for "A" hospitals in aggregate, "B" hospitals in aggregate, "C" hospitals in aggregate, and "D" and "F" hospitals together in aggregate. Table 1 reflects the mean incidence rate for each patient safety outcome for hospitals in each letter grade.

Estimating Mortality Risk

The published literature was reviewed to identify the average attributable mortality rate associated with each patient safety outcome when it occurs in the inpatient setting. The attributable mortality rates and the source of those data points are listed in Table 1. As the literature did not typically distinguish differences in mortality between better and worse performing hospitals, the same mortality rate was used for hospitals of all letter grades. The one exception to this is for Patient Safety Indicator 4 (PSI 04): Death among Surgical Inpatients with Serious Treatable Complications. For this measure, a hospital's score on the measure reflects the mortality rate when a serious, treatable complication occurs. As such, for this measure, we could aggregate data across each letter grade to determine a grade-specific mortality rate. The literature did not support any attributable mortality rate for Hospital-Acquired Conditions (HAC): Air Embolism.

While higher adherence to process and structural measures is generally linked to improvements in patient safety and care quality, the literature did not identify quantifiable reductions in mortality rates through improved performance for most of the process and structural measures used in the Hospital Safety Score. However, one structural measure used in the Hospital Safety Score, Intensive Care Unit (ICU) Physician Staffing, does have identifiable reductions in mortality risk. It is estimated that full implementation of Leapfrog's ICU Physician Staffing (IPS) standard by all U.S. hospitals could reduce ICU morality by 30% — from 12% to 8.4%.[1] We assumed a linear relationship between a hospital's adoption of Leapfrog's standard and reductions in mortality rates. Table 2 reflects the estimated excess mortality above 8.4% for each letter grade attributable to lack of full adoption of Leapfrog's IPS standard.

Calculating Mortality Rates per 1,000 Admissions

To estimate the mortality rate for each patient safety outcome in hospitals in each letter grade, we multiplied the mortality rate for each outcome measure by the respective mean incidence rate of that outcome for each Hospital Safety Score letter grade. As some measures apply only to certain kinds of admissions, such as surgical admissions or ICU admissions, we multiplied the mortality rates by the percentage of all admissions that apply to that measure. From the literature, we identified that 29% of all U.S. hospital admissions involve a procedure in the operating room[2] and 20% include an ICU admission.[3]

To estimate the impact of the lack of full adoption of Leapfrog's ICU Physician Staffing standard on patient mortality, we multiplied the incremental mortality rate by the percentage of hospital admissions that are admitted to the ICU.

While the literature we used to estimate the mortality rates for each preventable harm would ideally reflect the mortality that is directly attributable to that preventable harm in isolation, we recognize that some of the estimated mortality risk may be counted across

multiple measures. To account for this limitation, we reduced the mortality associated with the outcome measures by 50%.

Table 1. Mean Incidence Rate of Patient Safety Outcomes for Hospitals in Each Letter Grade and the Average Attributable Mortality Rate for Each Outcome.

	Mean Incidence Rate of Patient Safety Outcome per 1,000 Hospital Admissions				**Identified Attributable Mortality Rate**
Measure	**A**	**B**	**C**	**D & F Combined**	
Hospital-Acquired Conditions (HAC): Foreign Object Retained After Surgery	0.00%	0.00%	0.00%	0.01%	2.14% [4]
Hospital-Acquired Conditions (HAC): Falls and Trauma	0.04%	0.05%	0.06%	0.08%	5.50% [5]
Hospital-Acquired Conditions (HAC): Air Embolism	0.00%	0.00%	0.00%	0.00%	No identified mortality rate
Central Line-Associated Blood Stream Infection (CLABSI) in ICUs only	0.05%	0.08%	0.11%	0.15%	18.5% [5]
Catheter-Associated Urinary Tract Infection (CAUTI) in ICUs only	0.15%	0.19%	0.22%	0.26%	2.3% [5]
Surgical-Site Infections from Colon Surgery (SSI: Colon)	0.01%	0.02%	0.02%	0.02%	2.8% [5]
Hospital-onset Methicillin-resistant Staphylococcus Aureus (MRSA) Laboratory-identified Blood Infections	0.02%	0.03%	0.04%	0.04%	22.6% [6]
Hospital-onset Clostridium Difficile (C.diff.) Laboratory-identified Infections	0.33%	0.38%	0.39%	0.39%	23.00% [7]
Patient Safety Indicator 3: Pressure Ulcer Rate	0.02%	0.03%	0.03%	0.06%	7.23% [4]
Patient Safety Indicator 4: Death Among Surgical Inpatients with Serious Treatable Complications	0.80%	0.76%	0.81%	0.76%	A: 11.35% B: 11.77% C: 12.03% DF: 12.46% Note: Values are calculated from the actual PSI-4 data
Patient Safety Indicator 6: Iatrogenic Pneumothorax	0.04%	0.04%	0.04%	0.04%	6.99% [4]
Patient Safety Indicator 11: Postoperative Respiratory Failure	1.12%	1.21%	1.24%	1.34%	21.84% [4]
Patient Safety Indicator 12: Postoperative Pulmonary Embolism (PE) or Deep Vein Thrombosis (DVT)	0.38%	0.42%	0.44%	0.45%	6.56% [4]
Patient Safety Indicator 14: Postoperative Wound Dehiscence	0.17%	0.17%	0.17%	0.18%	9.63% [4]
Patient Safety Indicator 15: Accidental Puncture or Laceration	0.16%	0.18%	0.19%	0.21%	2.16% [4]

Table 2. Estimated Excess ICU Mortality Attributed to Lack of Full Adoption of Leapfrog's IPS Standard.

	Excess ICU Mortality Rate by Letter Grade				
	A	**B**	**C**	**D & F Combined**	**Note**
ICU Physician Staffing	1.91%	2.08%	2.73%	3.08%	Values are calculated from actual data; values reflect the incremental mortality above 8.4% due to the lack of hospitals' full adoption of Leapfrog's IPS standard[1]

Hospital Admissions

We used data from the 2014 American Hospital Association's Annual Survey to identify the number of acute care hospital admissions across the United States (33,066,720)[8] and how those admissions distribute across hospitals in each Hospital Safety Score letter grade.

Lives Lost and Lives Saved

We used the distribution of hospital admissions across each Hospital Safety Score letter grade with the number of lives lost per 1,000 admissions per letter grade to estimate the total number of lives lost for hospitals in each letter grade. We also used these data to calculate the number of lives that would be saved if hospitals with grades lower than "A" operated as safely as "A" hospitals.

Results

Table 3 reflects the key results of the analysis. The number of avoidable deaths per 1,000 admissions ranged from 5.13 lives per 1,000 admissions in "A" hospitals to 7.68 lives per 1,000 admissions in "D" and "F" hospitals. Compared to "A" hospitals, the differences in the estimated relative risk of an avoidable death is 8.5% higher in "B" hospitals, 35.2% higher in "C" hospitals, and 49.8% higher in "D" and "F" hospitals. It is important to recognize, however, that these results reflect average hospital performance in each grade category and individual hospital performance within a letter grade may vary.

Table 3. Rate of Avoidable Deaths per 1,000 Admissions and the Possible Lives Saved with Improved Performance.

	A	B	C	D & F Combined
Lives Lost/1,000 Admissions	5.13	5.56	6.93	7.68
Relative Risk of an Avoidable Death Compared to "A" Hospitals		8.5%	35.2%	49.8%
Distribution of Hospital Admissions	25.9%	29.7%	39.7%	6.5%
Lives Saved if All Hospitals Had an "A" Safety Record		4,275	23,699	5,485

Applying the mortality rates for each grade of hospital to the distribution of hospital admissions in 2014, we estimate 206,021 avoidable deaths in U.S. hospitals each year (43,903 in "A" hospitals, 54,620 lives in "B" hospitals, 90,994 in "C" hospitals, and 16,503 lives in "D," and "F" hospitals). We estimate 33,459 lives could be saved every year if "B" "C","D", and "F" hospitals had the same safety performance as "A" hospitals.

Conclusions

Efforts to reduce patient safety events have been plentiful, and yet elimination of all preventable harms remains elusive. While hospitals with a Hospital Safety Score of "A" have better performance than hospitals with lower grades, they still have significant opportunities for improvement. If hospitals with a grade lower than an "A" are able to achieve the safety performance of "A" hospitals, we estimate more than 33,000 patient lives could be saved.

The measures included in this analysis reflect a subset of all potential harms that patients may encounter in U.S. hospitals, and as such, these results likely reflect an underestimation of the avoidable deaths in U.S. hospitals. Also, we have only estimated the deaths from patient safety events and have not captured other morbidities that may be equally important. And while the absolute numbers presented in this analysis are likely an underestimation of the true impact on patients, the relative comparisons presented in this analysis likely hold across all harms, given that the underestimation is likely consistent across all hospitals.

How this study compares to other studies

There are no direct comparisons to other studies, as this analysis looked only at measures included in the Hospital Safety Score. Other studies that have estimated the number of lives lost from medical error range from 44,000 to 440,000,[9,10] with our estimate falling in the middle of that range. We believe our results are an underestimation of the total impact of avoidable death in U.S. hospitals.

Limitations

This analysis only utilized measures of patient safety harm included in the Spring 2016 Hospital Safety Score. There are a number of patient safety harms that are not currently measured and publicly reported. Examples include medication errors and diagnostic errors. The estimates of lives lost in this analysis are likely to be conservative.

The mortality rates we used in the analysis were generally the same for all hospitals. One might hypothesize that safer hospitals may actually have lower mortality rates when one of these events occurs. This would exaggerate differences we identified between better and worse performing hospitals.

We cannot quantify the true amount of double-counting of deaths that may occur between the different measures. The literature does not identify the potential impact intensivists have on patient harms in the ICU, so we made a conservative assumption that 50% of the deaths associated with the outcome measures are already captured in the ICU Physician Staffing mortality estimates. The analysis could be refined if one could better understand the impact that the presence of intensivists has on patient harms in the ICU.

References

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Appendix

Table A. Measures from the Spring 2016 Hospital Safety Score Used in the Analysis.

	Data Source	Reporting Period
Outcome Measures		
Hospital-Acquired Conditions (HAC): Foreign Object Retained After Surgery	Centers for Medicare and Medicaid Services (CMS)	07/01/2011-06/30/2013
Hospital-Acquired Conditions (HAC): Falls and Trauma	Centers for Medicare and Medicaid Services (CMS)	07/01/2011-06/30/2013
Hospital-Acquired Conditions (HAC): Air Embolism	Centers for Medicare and Medicaid Services (CMS)	07/01/2011-06/30/2013
Central Line-Associated Blood Stream Infection (CLABSI) in ICUs Only	2015 Leapfrog Hospital Survey	01/01/2014-06/30/2015
	Centers for Medicare and Medicaid Services (CMS)	04/01/2014-03/31/2015
Catheter-Associated Urinary Tract Infection (CAUTI) in ICUs Only	2015 Leapfrog Hospital Survey	01/01/2014-06/30/2015
	Centers for Medicare and Medicaid Services (CMS)	04/01/2014-03/31/2015
Surgical-Site Infections from Colon Surgery (SSI: Colon)	Centers for Medicare and Medicaid Services (CMS)	04/01/2014-03/31/2015
Hospital-onset Methicillin-resistant Staphylococcus Aureus (MRSA) Laboratory-identified Blood Infections	Centers for Medicare and Medicaid Services (CMS)	04/01/2014-03/31/2015
Hospital-onset Clostridium Difficile (C.diff.) Laboratory-identified Infections	Centers for Medicare and Medicaid Services (CMS)	04/01/2014-03/31/2015
Patient Safety Indicator 3: Pressure Ulcer Rate	Centers for Medicare and Medicaid Services (CMS)	07/01/2012-06/30/2014
Patient Safety Indicator 4: Death Among Surgical Inpatients with Serious Treatable Complications	Centers for Medicare and Medicaid Services (CMS)	07/01/2012-06/30/2014
Patient Safety Indicator 6: Iatrogenic Pneumothorax	Centers for Medicare and Medicaid Services (CMS)	07/01/2012-06/30/2014
Patient Safety Indicator 11: Postoperative Respiratory Failure	Centers for Medicare and Medicaid Services (CMS)	07/01/2011-06/30/2013
Patient Safety Indicator 12: Postoperative Pulmonary Embolism (PE) or Deep Vein Thrombosis (DVT)	Centers for Medicare and Medicaid Services (CMS)	07/01/2012-06/30/2014
Patient Safety Indicator 14: Postoperative Wound Dehiscence	Centers for Medicare and Medicaid Services (CMS)	07/01/2012-06/30/2014
Patient Safety Indicator 15: Accidental Puncture or Laceration	Centers for Medicare and Medicaid Services (CMS)	07/01/2012-06/30/2014
Process/Structural Measure		
ICU Physician Staffing (intensivists managing or co-managing ICU patients)	2015 Leapfrog Hospital Survey	01/01/2014-06/30/2015
	AHA Annual Survey	2014